CONSTRUCTION PRODUCTIVITY IMPROVEMENT AT A CONSTRUCTION BATTALION UNIT

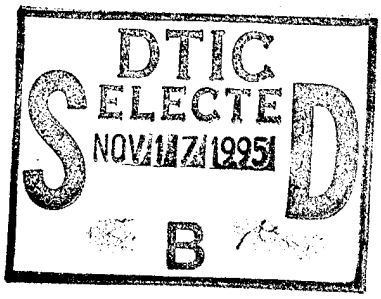
A Scholarly Paper Presented to

The Faculty of the Construction Engineering and Management Program

University of Maryland at College Park

by

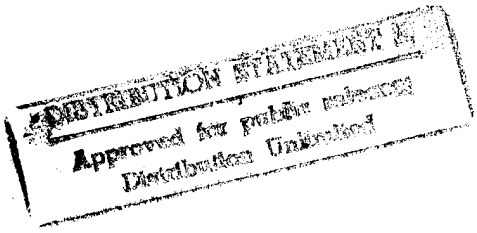
Mary J. Helinski



In Partial Fulfillment

of the Requirements for the Degree of

Master of Science (in Civil Engineering)



Approved:

_____

Faculty Advisor/Date

_____

Director, Construction Engineering and Management Program

HELINSKI, M.

AD NUMBER	DATE	DT ON
	3 November 95	

1. REPORT IDENTIFYING INFORMATION

A. ORIGINATING AGENCY

NAVAL POSTGRADUATE SCHOOL,MONTEREY,CA 93943

B. REPORT TITLE AND/OR NUMBER

Construction productivity improvement at a construction battalion unit

C. MONITOR REPORT NUMBER Aug 95

HELINSKI, Mary J. Thesis, U-Maryland

D. PREPARED UNDER CONTRACT NUMBER

NOO-123-91-G-0566

2. DISTRIBUTION STATEMENT

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED

RE
1.
2.
3.
4.
5.

D
1.
2.

19951115 011

DTIC Form DEC 91 50 PREVIOUS EDITIONS ARE OBSOLETE

ABSTRACT

Utilizing management techniques such as Continual Process Improvement, Total Quality, and Corporate Reengineering, analyze, streamline and improve critical construction and business processes at a Construction Battalion Unit, to ensure its competitiveness and effectiveness into the future.

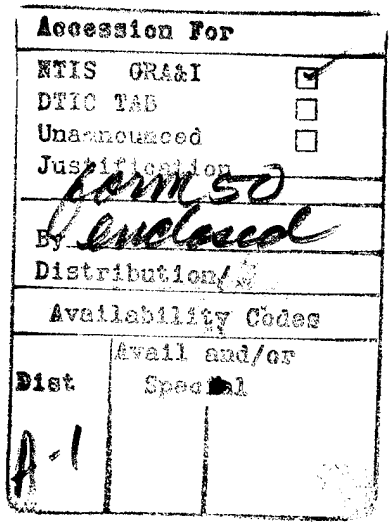


TABLE OF CONTENTS

8. Appendices

   A. References

   B. Glossary

   C. CBU organization Chart

   D. NCF Project Planning Policy

   E. Flow chart -- Material ordering (current)

   F. Flow chart -- Material ordering (streamlined)

LITERATURE REVIEW

In the last couple of decades, American Industry as a whole has experienced a major decline in producing inexpensive, quality merchandise. Japanese industry, however, has literally taken over in nearly every technological market. Their success is attributed primarily to an American statistician, Dr. W. Edwards Deming. Volumes of books have been written on his Total Quality approach to management. Although a recognized pioneer in this process oriented management style, he is not alone. At least an equal number of books have been written on similar management principles. They all have a couple of common themes; orientation towards processes rather than tasks, customer defined quality, service and satisfaction, complete involvement of employees, and continual improvement.

The U. S. Navy has adopted a version of Dr. Deming's principles called Total Quality Leadership, vice management. At NAVFAC, the basic principles outlined in Mary Walton's book The Deming Management Method have been adopted, a pocket guide endorsed and distributed based on Michael Brassard's Memory Jogger, and basic in-house training courses started. These books and courses are quite instructive for the philosophy behind TQM and the nuts and bolts of statistical analysis, but leave major gaps in the "how to start" CPI at the organizational level.

William E. Conway expands on the Walton book in his books The Quality Secret:The Right Way to Manage, and Waste Chasers. He upholds all of Demings techniques and adds some practical guidelines and concepts to follow.

Another book, which uses the same basic principles and philosophies of TQL, but different terminology, is Business Process Improvement by H. James Harrington. This book, however, is fairly explicit on steps to take to actually implement this type of management technique at your own office. It provides the practical, rather than the philosophical information to achieve CPI management.

One last book used in this paper is Reengineering the Corporation by Michael Hammer and James Champy. This management technique shares the same basic principles of the others, however, it does not agree that CPI will solve all the major management problems. For major problems, it is more effective to throw out the existing process and "start over" rather than trying to improve it. This approach is aimed at radically redesigning the fundamental thinking of the process.

Numerous software packages specifically designed for Construction Management applications are available commercially. Two estimating packages, Advanced Construction Estimating and Timberline, three scheduling packages, Primavera, Microsoft Project and Microtrack, and the Timberline series for job cost control were investigated.

Many sources within the DOD and NAVFAC were reviewed which outline the current doctrine and policies governing operation of a CBU. They are listed in Appendix A. As well as these written guidelines, many unwritten policies are also included in this paper.

DESCRIPTION OF PROJECT

A CBU is a 45 man unit consisting of various ratings or construction trades, including 8 EOs, 3 CEs, 3 UTs, 6 SWs, 13 BUs, 5 CMs, 2 EAs, 2 SKs, 1 YN, plus an AOIC and OIC. These tradesmen have varying levels of experience, ranging from a trade school education to twenty year plus construction experience.

The Navy has a mandated sea-shore rotation policy in order to allow sailors relief from deployments (NAVADMIN 149-93 par 3). Although shore duty billets existed at PWDs and other miscellaneous commands throughout the U.S. for Seabees, there were not enough billets to meet the Seabee sea-shore rotation requirements. CBUs were first created in the late 1960s in order to alleviate this problem. Over the years, these CBUs have become a desirable asset to the ISIC as an additional optional for base maintenance. The number of CBUs grew to a maximum of 23 in the late 1980s, with many other requests denied.

The original mission of providing shore duty billets is still valid today, however, additional taskings have also been added, such as augmenting deploying NMCBs and Fleet Hospitals (OPNAVINST 5450.46J). The augments for both NMCBs and FHs are valid mission requirements, however, the types of personnel needed to meet these requirements, primarily EOs and CMs for NMCBs and UTs and CEs for FH, does not match up with the types of personnel available in a CBU. Altering the rate structure of

a CBU to make them match these requirement would make the CBU incapable of performing base construction projects, which primarily require BUs.

In the last few years, given the large scale downsizing of the military, and changes to budget management policies, even the highly desireable CBUs have come under attack. Although the CBU provides construction projects and operates on a small budget ($70,000 annually, excluding project costs), they are quite expensive when the cost and availability of military personnel are considered. Direct labor percentage at a CBU runs approximately 30% of their total labor effort (CBU Operations reports FY93) and the ISICs are now willing to trade a CBU for much needed sailors and hire civilians or contractors to perform construction projects at a cheaper cost. Due to these factors and other political issues, four CBUs were planned for disestablishment and six more for relocation in 1993 (CNO ltr June 94).

Although CBUs are autonomous units and can operate independently of other Seabee units, NAVFAC has stipulated that CBUs follow all NMCB operating policies and procedures (OPNAVINST 5450.46J). This includes the way they organize the unit, plan and execute projects, evaluate and conduct training as well as perform administrative functions. Standardization is important, particularily when personnel rotate between these units every two to three years. CBUs now administratively report to the Naval Construction Regiments for this type of guidance and oversight, just as NMCBs and other NCF units do.

OBJECTIVES OF STUDY

The objective of this study is to improve the CBUs productivity, quality and competitiveness using a combination of CPI, BPI and reengineering techniques. This paper will organize the CBU to conduct this type of program, select, analyze and streamline/reengineer five specific processes, identify ways to measure and control these processes, and recommend future courses of action.

METHODOLOGY

TECHNIQUES USED

Various techniques from the literature mentioned earlier will be combined in this analysis. The actual steps used for this analysis will roughly follow Harrington's five Phases for Implementation; Organizing for Improvement, Understanding the Process, Streamlining, Measurement and Control, and Continuous Improvement (Harrington pg 21-22).

Intermixed with Harrington's systematic BPI approach, some of the reengineering techniques from Hammer & Champy and some Continual Improvement Tools from Brassard will also be used.

DATA COLLECTION PROCESS

CBUs all operate in the same manner. Data for this paper was gathered at CBU 422, located at the Washington Navy Yard. All senior department heads as well as the AOIC and OIC aided in the beginning stages of the analysis, specifically the following items:

- Listing of critical processes and subprocesses
- Selecting processes for improvement

- defining boundaries
- identifying inputs, outputs, customers
- drawing flow charts
- process evaluation for times and costs

Although PIT members and other BPI tasks are identified for the CBU to actually complete the entire BPI process, the actual analysis and recommendations presented in this paper is the sole work of the author.

MISSIONS AND STRATEGIC GOALS

Prior to the start of any process improvement, the missions and strategic goals of the organization must be identified. The mission of a CBU is one of the most highly disputed Seabee issues at NAVFAC and OPNAV. An entire paper could be written discussing this issue, but for the purposes of this analysis, the following will be assumed:

- NMCB augment billets will be provided by reserve personnel.
- One active duty CBHU will be created to provide for the FH mission, with the remaining FH requirements filled by reserve personnel.
- CBUs will not have a wartime mission.
- CBUs can be called upon to conduct disaster relief and humanitarian assistance as needed.

The mission statement for a CBU will therefore be as follows:

The primary mission of a CBU is to provide mandated Shore duty billets for deploying Seabees and further the construction skills of its assigned Seabees through on the job training at local construction projects for their ISIC. CBUs will have a secondary mission to conduct disaster relief and recovery as well as humanitarian assistance and civic action operations.

The strategic goals of a CBU are as follows:

- Perform timely, quality construction and repair projects for ISIC and other customers.
- Increase construction skill level of all assigned Seabee personnel.
- Ensure unit personnel and TOA readiness in response to mobilization for disaster or humanitarian operations.

FIVE PHASES OF IMPLEMENTATION

PHASE A -- ORGANIZING FOR IMPROVEMENT

1. Establish EIT and BPI Czar

Appendix C shows the organization chart for a CBU. The EIT will consist of the OIC and AOIC. The BPI czar will not be a designated position, but rather an individual (E-5 or above) who is best suited for the role. This czar will be someone highly motivated and knowledgeable of the BPI process with a willingness to coordinate the various PITs. The Czar will be a full time position for the first few years while this management method is implemented, and when method is functional, position can be reduced to part time. Czar will also be responsible for educating all CBU personnel.

2. Develop Improvement Model

The initial model outlined in this paper should be updated as BPI techniques are firmly established at the CBU.

3. List critical processes & subprocesses and select those for improvement

There are different approaches available in prioritizing processes to be improved. The informed approach (Harrington pg 39) ranks the processes based on the impact they have on the external customer and the opportunity they have for improvement. The scale used ranges from one to three, three being highest impact or largest improvement,

respectively. Those processes receiving the highest total scores should be top priority for improvement. The external customer for these processes is the U. S. Navy. The following processes were identified and ranked using the informed approach.

PROCESS	CUST	IMPROVE
Obtaining Work	3	1
Obtaining Funds	3	1
Estimating/Scheduling Project	2	3
Material Ordering	2	3
Material Receipt	1	1
Outage Requests	2	2
Obtaining Permits	3	1
Set up Field Office	1	1
Assign Project Tools	3	1
Assign Project Equipment	3	2
Assign Project Crews	3	2
Project tracking/status	2	3
Transporting crews to site	2	1
Project closeout	1	1
Project quality control	2	2
Project vs other labor efforts	3	2

The six underlined processes all scored a total of five and relate directly to project planning and resource assignment. The project vs other labor efforts process will not be analyzed in this paper, however, should improve as the other five processes are improved.

In addition to prioritizing processes by customer impact and improvement opportunity, these processes should also be evaluated for the impact resources, returns, risks and rewards have on them (Harrington pg 41). A process with an extremely high risk or large resource requirement may not be a good choice for the first process improved, even if it scored high using the informed approach.

Resources available at the CBU are very limited for any of the five selected processes. With only 45 personnel it is difficult to dedicate more than 2 or 3 personnel full time on BPI. Other resources, such as computer hardware, software and technical support is also very limited. However, since all CBUs and NMCBs operate under the same policies, other Seabees and support personnel could be utilized in addition to those already assigned.

The returns for improved project planning and resource assignment would result in a much higher direct labor rate as well as the ability to perform more projects. The returns for project status/tracking would be the ability to identify problems and reduce waste during project execution. Returns for improved material ordering would be better

project execution and higher direct labor rate.

The risk to change current project planning/execution would be dramatic and affect the entire NCF. Risk to change material ordering process could affect the entire Federal Procurement system.

Rewards for PIT members and CBU as a whole would be tremendous for any of the five processes. Not only do they improve their own individual operations, they improve the operations for the entire NCF.

Risk is the primary disadvantage to proceeding with the five selected processes. The returns, however, seem to be worth proceeding.

4. Select process owners and PIT members

The Operations Officer is responsible for the daily operations of all CBU assets and will be the process owner for all the selected processes.

The members of the PIT will consist of the Equipment Officer, a BU estimator, Supply Officer and Assistant Operations Officer from the CBU, a NDW procurement manager and a NAVFAC or Regiment Seabee support manager. Other individuals, specifically other trade estimators at the CBU, should be brought in periodically for their expertise.

5. Define process scope and mission

The process scope and mission for the PIT for these five processes will be:

Apply BPI and reengineering to the total project planning process, specifically to estimating, scheduling, resource assignment and material ordering with the goal of reducing process time, errors, waste, duplication of effort and no-value-added activities as well as provide feedback and accurate measurements of actual efforts versus planned efforts. Improvements to process not constrained to existing NCF procedures.

6. Define boundaries

Processes must have a beginning and ending point as well as upper and lower limits. These limits are summarized below for the five selected processes.

ESTIMATING

Upper	estimating guide exists and available
Lower	filing/returning reference material
Start	project identified and funds available
End	BOM complete

MATERIAL ORDERING

Upper	GSA & stock system information exists
Lower	vendor information logged for future reference
Start	BOM complete and funds available
End	materials received

PROJECT EQUIPMENT

Upper	TOA equipment at CBU
Lower	equipment usage and maintenance data kept
Start	valid need for equipment
End	equipment assigned to project

PROJECT CREWS

Upper	CBU has assigned manning of 45
Lower	personnel depart for leave, medical reasons
Start	other project crew requirements known
End	personnel assigned to project (that day)

PROJECT TRACKING

Upper	project schedule & estimate complete
Lower	forward status reports
Start	fill out timecards & material used reports
End	analyze reports

7. Identify customers

The external customer for all these processes is the U.S. Navy. Other customers are:

PROCESS	PRIMARY	SECONDARY	INDIRECT
Estimating	project sup	requesting unit	supply
Material Orders	project sup	NDW supply	other sups

Equipment Assign	project sup	equip maint	other sups
Crew Assignment	project sup	training	other sups
Project Tracking	project sup	operations	other sups

8. Identify inputs, outputs and other interacting processes

The major inputs needed for the planning processes are as follows:

- guide for estimating materials, equipment and crews (NAVFAC P405)
- cost & order information for materials (federal stock system & catalogs)
- personnel and equipment availability
- other project requirements and priorities

Outputs are:

- accurate estimate and schedule
- complete availability of project resources

Other interacting processes:

- timekeeping
- material delivery
- cost accounting

9. Determine measurement data

Process measurements are categorized as effectiveness, efficiency, and adaptability (Harrington pg 74). Effectiveness is the extent to which the process meets customer expectations, efficiency is the extent to which process resources are

minimized and adaptability is the extent to which the process can handle special circumstances. Specific measurements to be taken for these processes will be accuracy, timeliness, cycle time, and flexibility. They will be explained in greater detail in Phase D.

PHASE B -- UNDERSTANDING THE PROCESS

10. Determine Process Improvement or Reengineering

Before detailed flow charts are prepared for analysis and application of BPI, the processes should be evaluated for reengineering possibilities.

CPI is accomplished through streamlining an existing process, with the basic premise that the existing process is still functional but needs some improvement. Streamlining techniques can be broken into the following categories (Harrington pg 132): Bureaucracy elimination, Duplication elimination, Value Added Assessment, Simplification, Process cycle-time reduction, Error Proofing, Upgrading, Simple Language, Standardization, Supplier Partnerships, Big picture improvement, automation/mechanization.

Reengineering, however, works under the premise that the existing process cannot be fixed and must be discarded. It is formally defined as "the fundamental rethinking and radical redesign of a business process to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed." (Hammer/Champy pg 32).

Appendix D is the current procedure for NCF project planning. This includes estimating, scheduling, ordering material and creating safety and quality control plans. A nine folder project package is created. This package is rarely referred to during project execution. The only automated feature is the schedule, which is done on Microtrack. This software package is not capable of using actual data to adjust the schedule. Timekeeping of actual mandays worked is not directly related back to the project. Percent completion of a project is an estimate of WIP. Master activity lists, construction activities, precedence diagrams are all created manually, on separate forms then inputted into Microtrack. Estimates are made manually using the P405, then entered onto a computer. A separate BOM is also manually created, recopied onto a different form for procurement, and then inputted into a computer for ordering. Crews and equiment are included in the construction activities sheets. Crews are also included in the Microtrack schedule. The duplication of effort and waste involved in these processes is so vast that drastic redesign is needed.

11. Create Process Flow Charts, Cost and Time Data

Although material ordering is part of the overall project planning process, which is being reengineered, parts can also be streamlined. The existing process flow chart and time data is included as Appendix E. Time data is divided into two categories; process time and cycle time. Process time is the time it actually takes an individual to perform the activity. Cycle time includes the time it takes to get from one activity to another. For

example, it may take one minute to sign a document (process time), but it may sit in that person's in basket for a day before being signed (cycle time). Specific delays are included directly in the flow chart. Like the project planning process, no feedback is provided.

PHASE C -- REENGINEERING/STREAMLINING

12. Reengineering Project Planning & Tracking

Prior to redesigning the Project Planning process, some basic principles and assumptions must be considered. First, this process must be standardized throughout the NCF and not just applicable to a CBU. Second, the system must be compatible with Federal Procurement Policies, specifically utilization of the Federal Stock System for material procurement. Third, the system must be useable at remote deployment sites. Fourth, the system must be flexible to include some standard construction packages unique to Seabee field practices. Fifth, the system must be user friendly since large numbers of personnel unskilled in computers will operate it. Sixth, the system should be commercially available and supportable to ensure continual upgrades in technology and training and limit the need for in-house expertise. It is assumed that the new process will be completely automated.

Two commercial estimating software packages were investigated; Advanced Construction Estimating (ACE) and Timberline. Scheduling packages investigated were

Primavera and Timeline. Both ACE and Timberline estimating packages can accept an industry standard database or create their own. These databases are based on the standard specification divisions and include material, labor and equipment costs, formulas for takeoffs, standard reports as well as additional fields. Both also have a separate integrator which can interface the estimate to Primavera scheduling software. Timberline has additional separate software packages which can enhance the estimate by creating work packages and customizing reports as well as interfacing with actual job costs, payroll, procurement management and general ledger information. Timberline also has a greater capability for customizing than ACE. Primavera and Timeline scheduling packages are very similar in their capabilities, however, only Primavera is compatible with the estimating packages. Because of its capabilities the Timberline applications Precision Estimating, Precision Estimating Plus, Job Cost, Payroll, and Primavera Integrator as well as Primavera Schedule will be used in the project planning process redesign.

In order to standardize this system throughout the NCF, the two Regiments will be responsible for creating and updating standard work packages, maintaining the network, updating stock system information, and providing training. This will ensure standardization across the NCF as well as take the overhead burden off the construction units. The system will be protected at the Regiment level so CBUs and other NCF units cannot change the database. They can alter their own estimates for local cost variations and order information. This information will also be reported to the Regiment for possible

inclusion or change to the database. The system will be networked to all NCF units with the option of laptop computers for field use. Minimum hardware requirement at the CBU is an IBM 386 25 Megabyte hard drive with 1 Megabyte RAM.

The current planning and estimating guide used by Seabees is the P405 which was last updated in 1983. It only lists estimated manhours (with recommended crew) to perform a specific task. For example: 1000 SF of 12x8x16 in concrete block takes 167 MH (suggested crew of 8-10 BUs). Since many commercial estimating guides are available and updated frequently, both on hard copy and disk, it is ridiculous to duplicate this effort. Therefore, the Means commercial database packages for general construction, civil, mechanical and electrical will be used as the data base. Seabees are already familiar with the Means guide, therefore adapting to an automated version should be an easy transition. These packages will be edited and enhanced by the Regiment to customize for Seabee construction. Specifically, field construction such as rapid runway repair, erecting butler buildings or "strongbacking" tents, will not be included in these databases. The Regiment will create these customized work packages to augment the Means information.

Material ordered for Seabee projects can only be purchased commercially if it is not available through GSA or the Federal Stock System. Neither GSA or the Stock System specialize in construction materials, however, basic materials, such as lumber, nails, hammers, pipe are available. The entire stock system is available on CDROM

through software packages such as Fedlog, Haystack and Partsmaster. Partsmaster is the most advanced of these applications and is updated quarterly. Any item can be searched by whole or partial NSN, description, size, etc. An interface between the estimating database which generates the BOM and the stock system is needed. The Timberline estimating package has a field available to input order information. Since no program currently exists to directly interface the estimating database with Partsmaster, the Regiment will be tasked with cross checking all items on the estimating data base against the GSA and stock system and entering the stock number into the database. This data entry will be quite time consuming, but will only need to be inputted once, then periodically updated. Local procurement information will also be added as that information is obtained. The BOM and purchase orders are then automatically generated from the estimating package. The purchase orders can be customized into Standard Navy procurement forms.

Tracking of actual costs will be done through the Job Cost application. Standard categories are materials, equipment, labor, subcontractors and general. Actual productivity and overruns can be closely monitored. Revised schedules can be generated with this information. What-if drills can be conducted between multiple projects to maximize resource allocation. Estimates and actual costs for overhead and indirect project labor, which have not been logged before, should also be included and tracked. Standardized reports on paper or laptop computers can be used in the field to complete this information. The Regiment or home base can then input information into Job Cost

package.

Assignment of equipment and personnel for projects will be done during the estimating and scheduling phase with the other resources and then adjusted between projects. However, the same equipment may be needed for daily operations or periodic maintenance, or the personnel may be in training or on leave, which will not be reflected in the various projects. The payroll package can actively manage these "other" activities on a daily basis and directly interface with the project schedules to level all resources.

Once this redesigned process is implemented, a detailed flow chart including process and cycle times can be made and then analyzed and streamlined for continuous improvement.

13. Streamlining Material Ordering Process

A large portion of the material ordering process was reengineered, specifically the automatic identification of all GSA and stock items, semi-automatic identification of locally procured items, and automatic printout of procurement forms. However, the process from that point on can still be improved. Supplier partnering with both the local Navy procurement office and commercial vendors is needed. The partnering agreements to be reached with the procurement office is threefold. First, since Timberline generated procurement orders are nearly error free, the procurement office will conduct only random checks rather than verify all procurement requests, for both stock items and local

procurements. Second, CBU will have complete authority to order commercial items from any local vendor who has a partnering agreement without having to get more than one quote or go through the procurement office. Third, CBU personnel will have access to procurement office computer to monitor receipt of stock system materials. Both CBU and procurement office will jointly establish partnering agreements with a few local vendors for commonly required materials not in the stock system and update them annually. The streamlined process reflecting these changes is shown in Appendix F. The process and cycle times are estimates only, since the streamlined process has not been implemented.

PHASE D -- MEASUREMENT AND CONTROL

14. Eleven W's

There are eleven questions which should be answered when you are determining how to measure and control your process (Harrington pg 165). They are: why, where, what, when and who should you measure, who should do the measuring, who should provide feedback, who should audit, who should set business and challenge targets, and what should be done to solve problems. For these processes, measurements need to be taken to monitor productivity and provide feedback on where the process is not working well. Business targets should be set by the Regiment and challenge targets by the CBU. The Regiment should audit the process as an independent source. The Regiment should also be involved in the problem solving, since it watches over all CBUs and can provide additional insight. The actual measuring and feedback will be done at the CBU. The what, where and when to measure is detailed below.

- BOM usage and price accuracy will be measured by both the Regiment and CBU for standard prices and local variations. The CBU will monitor this data daily as it is entered into the job cost package and the Regiment will monitor at project completion.
- Labor accuracy will be measured by both the Regiment and CBU for discrepancies or crew variations. The CBU will monitor this data daily as it is entered into the job cost and payroll package and the Regiment will monitor at project completion.
- Equipment usage accuracy will be measured by both the Regiment and CBU. The CBU will monitor this data daily as it is entered into the job cost and payroll and the Regiment at project completion.
- Stock number and order information accuracy will be measured through periodic audits by the local procurement office and by the CBU project sup as materials are received.
- The Schedule will be monitored weekly by the CBU operations officer and at completion by the Regiment.
- Estimate preparation times will be accurately recorded for comparison and tracking by the respective CBU company commanders, noting specific problems for future corrections.
- Delays between order and receipt of materials for each vendor and stock system will be tracked by CBU supply officer.

These measurements must provide understandable, timely and accurate feedback to the personnel actually performing the task and will be used to evaluate their work. Timberline can generate any customized report needed.

PHASE E -- CONTINUOUS IMPROVEMENT

This paper has only identified a few processes for improvement and set ground rules for continuing the BPI process. It has barely scratched the surface for ensuring CBU productivity and competitiveness. Harrington (pg 206-214) has created a six level qualification process on which to rank the processes, ranging from unknown (six) to world class (one). The processes must meet certain requirements in the following categories in order to progress to the next level: End-customer-related measurements, Process measurements and/or performance, Supplier Partnerships, Documentation, Training, Benchmarking, Process adaptability, Continuous Improvement. These levels have no real significance other than an easily understandable indication of how well the company is progressing. The processes improved in this paper have reached a level five or understood. As the new processes are implemented and measurement data collected, the PIT can analyze the data and attack new problem areas, or focus on other processes.

CONCLUSIONS

Reengineering of the project planning process is a large risk for the NCF. It is a drastic change to conducting business, but the huge reduction in duplication efforts will be a tremendous labor and cost savings. Once the system is implemented, the effect on the CBU should be a large increase in direct labor productivity and a decrease in material delays. Timberline is a fairly easy package to learn and Seabees are somewhat familiar with Means, so the training requirements needed will not be too extensive. Most NCF units have or are receiving IBM 486 hard drives, so hardware and networking requirements will also be insignificant. The primary cost to implement the system will be in software procurement and technical support from Timberline and Means as well as costs at Regiment to create standard work packages, input stock system information, install network and conduct training programs and instruction manuals. There will also be annual maintenance costs to update databases, maintain the system, provide training and maintain technical support. Actual cost savings can be estimated once the system is in place and actual data accumulated for revised estimate preparation times. However, the system could probably pay for itself within the first year it is implemented, making CBUs more productive, competitive and able to concentrate on constructing a quality product.

RECOMMENDATIONS FOR FUTURE WORK

Once the new project planning system is implemented, the redesigned process must be flow charted and process and cycle times documented. Measurement data collected must be available to the PIT so the redesigned process can be analyzed for possible problems and streamlined.

A feedback system from the local procurement office must be developed which can accurately track orders within the stock system and provide timely feedback to the CBU. Timberline has a material purchasing and receiving application which could possibly be applied to this process.

Personnel and equipment assignments to specific projects are done through the estimating and scheduling applications, however, more detailed planning including planned maintenance and repair periods can be accomplished through Timberlines Payroll package. This application should be explored for both equipment and personnel to automate and streamline the entire resource scheduling process.

PITs should be assigned to other processes not included in this analysis as the CBU can afford to apply the resources needed.

REFERENCES

Conway, Williams E., 1993, The Quality Secret: The Right Way to Manage, Conway Quality, Inc., Nashua, NH.

GOAL/QPC, 1988, The Memory Jogger Plus, Second Edition, Methuen, MA.

Hammer, Michael J. & James Champy, 1993, Reengineering the Corporation: A Manifesto for Business Revolution, HarperBusiness, New York, NY.

Harrington, H. James, 1991, Business Process Improvement, McGraw-Hill, Inc., New York, NY.

Symantec Corporation, 1992, Timeline Users Manual, Version 1.0.

Software Shop Systems, 1991, Advanced Construction Estimating, Version 1.12, Farmingdale, NJ.

Timberline Software Corporation, Medallion, 1989, Job Cost.

Timberline Software Corporation, Medallion, 1989, Payroll.

Timberline Software Corporation, Medallion, 1989, Purchasing Manager.

Timberline Software Corporation, Precision School, 1993, Precision Estimating student Workbook.

Timberline Software Corporation, Precision School, 1993, Precision Estimating Plus student Workbook.

Timberline Software Corporation, Precision School, 1989, Primavera integrator.

U.S. Department of Navy, 1989, Construction Battalion Operations Student Guide, Naval School, Civil Engineer Corps Officers, Port Heuneme CA, topic 2000.

U.S. Department of Navy, Sep 1993, CBU 422 Operations Report, CBU 422, Washington Navy Yard.

U.S. Department of Navy, Jan 1980, Construction Battalion Unit Handbook P-314, Naval Facilities Engineering Command, Alexandria, VA.

U.S. Department of Navy, 1993, Doctrine and Policy Governing The Naval Construction Force, OPNAVINST 5450.46J, Chief of Naval Operations, Arlington, VA.

U.S. Department of Navy, 3 June 1994, Force Structure Modification for CBUs, CNO Ltr Ser N446/4U580262, Arlington, VA.

U.S. Department of Navy, 1985, Naval Mobile Construction Battalion Crew Leaders Handbook, Naval Facilities Engineering Command, Alexandria, VA.

U.S. Department of Navy, Feb 1985, NCF Manual P-315, Naval Facilities Engineering Command, Alexandria, VA.

U.S. Department of Navy, 1988, Operations Officer's Handbook, COMCBLANT/PACINST 5200.2A, Little Creek, VA & Pearl Harbor, HI, section I-IV.

U.S. Department of Navy, 1993, PERSTEMPO Sea-shore rotation, NAVADMIN 149-93, Washington, D.C.

U.S. Department of Navy, 1988, Procedures for Naval Construction Force Timekeeping, COMCBLANT/PACINST 5312.1A, Little Creek, VA & Pearl Harbor, HI.

U.S. Department of Navy, 1983, Seabee Planner's and Estimators Handbook, P-405, Naval Facilities Engineering Command, Alexandria, VA, chpt 2.

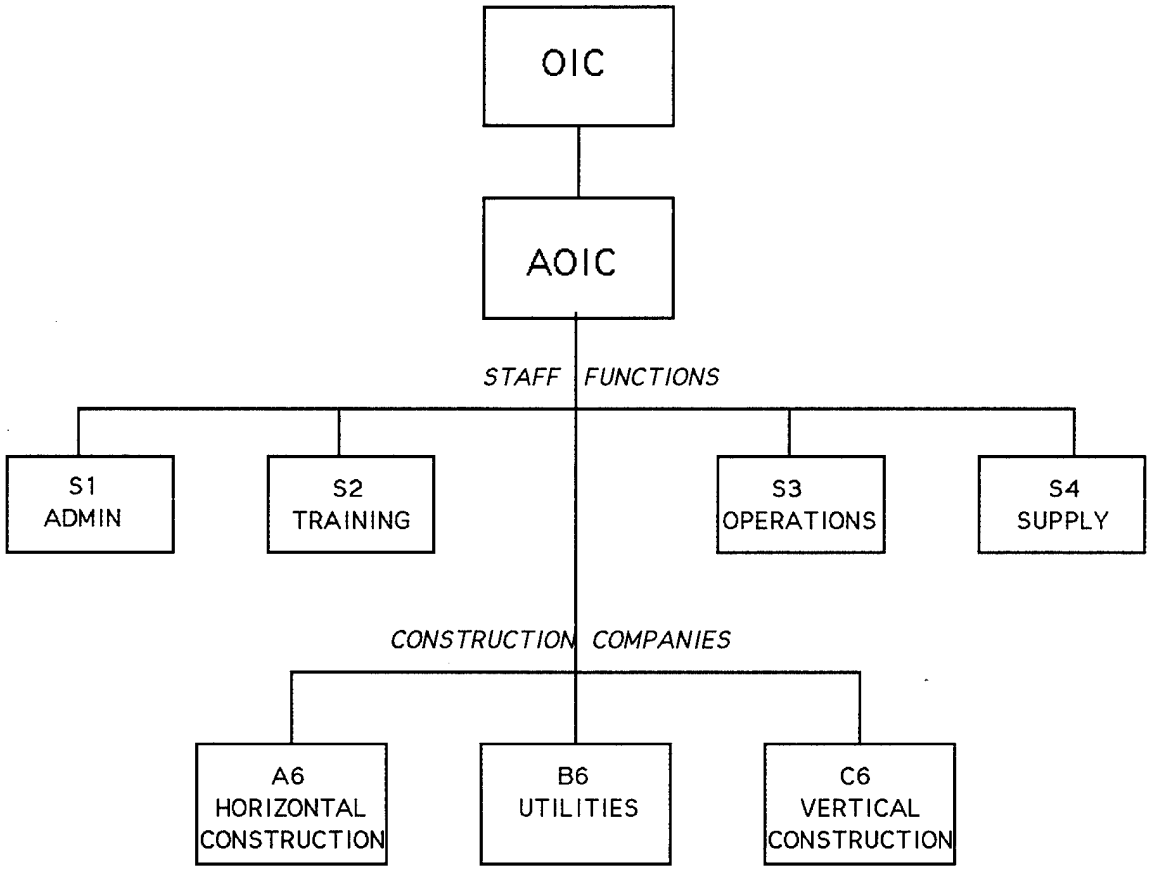
Walton, Mary, 1986, The Demming Management Method, Dodd-Mead, New York, NY.

GLOSSARY

AOIC	Assistant Officer in Charge
BOM	Bill of Material
BPI	Business Process Improvement
BU	Builder
CBHU	Construction Battalion Hospital Unit
CBU	Construction Battalion Unit
CE	Construction Electrician
CM	Construction Mechanic
CNO	Chief of Naval Operations
CPI	Continual Process Improvement
DOD	Department of Defense
EA	Engineering Aid
EIT	Executive Improvement Team
EO	Equipment Operator
FH	Fleet Hospital
FY	Fiscal Year
GSA	General Services Administration
ISIC	Immediate Superior in Charge
MH	Man Hours
NAVFAC	Naval Facilities Engineering Command

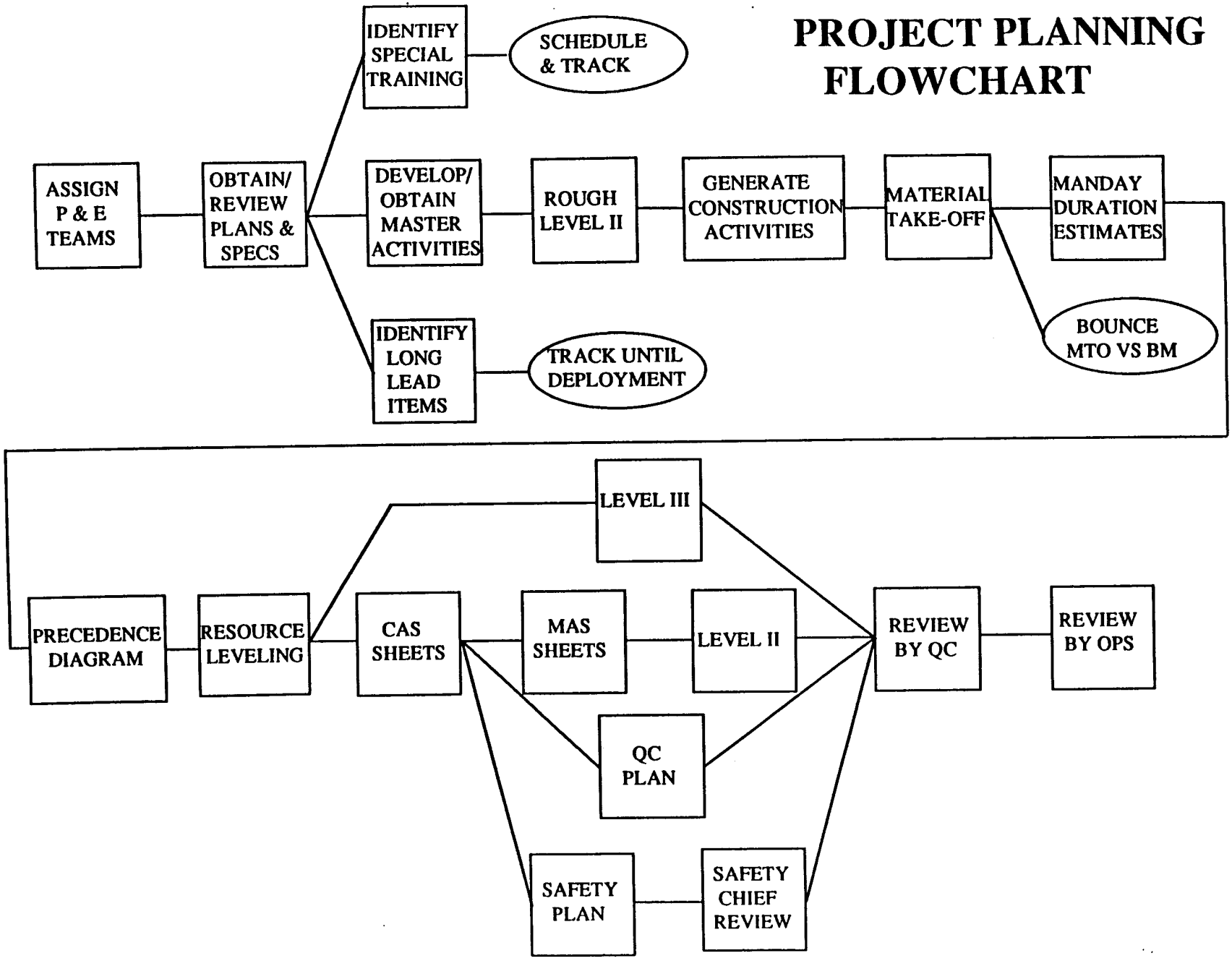
NCF	Naval Construction Force
NDW	Naval District Washington
NMCB	Naval Mobile Construction Battalion
NSN	Navy Stock Number
OIC	Officer in Charge of a CBU
OJT	On the job training
PIT	Process Improvement Team
PW(D/C)	Public Works (Department or Center)
Seabee(s)	NMCB or CBU Tradesmen or Personnel
SK	Storekeeper
SW	Steelworker
TOA	Table of Allowance
TQL	Total Quality Leadership
UT	Utilitiesman
WIP	Work in Place
YN	Yeoman

CBU ORGANIZATION CHART



APPENDIX C

PROJECT PLANNING FLOWCHART



MASTER ACTIVITY LISTING

PROJECT #_____ TITLE_____

Master Act. Number/ Title	Master Activity Description	MD's	Duration

APPENDIX D
2/7

LEVEL II BARCHART

TOTAL MD'S EST 790
TOTAL MD'S TASKED 790

PROJECT # XX7-830
TITLE ADMIN BUILDING

ACT #	MASTER ACTIVITY	MD'S	JUN 4	11	18	25	JUL 2	9	16	23	30	AUG 6	3	20	27	SEPT 3	10	17	24	OCT 1	8	15	22	29	NOV 5	12	19	
1000	SITEWORK	50	25	25																								100%
2000	UNDERSLAB UTIL.	60			20	20	20																					90 %
3000	FOUND. & SLAB	90			30	30	30																					80 %
4000	WALLS	150						30	30	30	30	30																70 %
5000	ROOF/CANOPY	150											30	30	30	30	30											60 %
6000	ROUGH UTILITIES	40																20	20									50 %
7000	INTERIOR FINISH	120																	30	30	30	30						40 %
8000	FINISH UTILITIES	40																					20	20				30 %
9000	EXTERIOR FINISH	90																30	30	30								20 %
	TOTAL	790																										10 %

MD'S SCHEDULED THIS MONTH	150	170	120	190	160	
CUMMULATIVE MD'S SCHEDULED	150	320	440	630	790	
% COMPLETE SCHEDULED	19	41	56	80	100	
CUMMULATIVE MD'S EXPENDED						
ACTUAL % COMPLETE						

APPENDIX D
3/7

ESTIMATING WORKSHEET

PROJECT LOCATION	PROJECT TITLE						PROJECT NUMBER			BM NUMBER	DATE PREPARED
PROJECT SECTION	ACTIVITY NUMBER			DRAWING NUMBER			PREPARED BY			CHECKED BY	
DESCRIPTION							BM LINE ITEM	UNIT OF ISSUE	TOTAL QTY	REMARKS	

TIME SCALE REPORT by EARLY START

```
     Activity                        MAR
Num  Description                     01  02  03  06  07  08  09  10  13  14  15  16  17  20  21  22  23  24
0101 MOVE IN              6BU 1EO>========>  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0401 PREFAB RST BEAM/CANOPY:  .3SW>-------------------->.............................................
0402 PREFAB FORM SCAFF/CANO: .6BU>---------------------------------------------------->
0201 PREFAB RST FTG/SLAB    :    .3SW>--------->.................>  .   .   .   .   .   .   .   .   .
0301 PREFAB FORM LINTEL     :    .3BU>--------->  .   .   .   .   .   .   .   .   .   .   .   .   .
0202 PREFAB FORM SLAB       :    . 3BU>=======>   .   .   .   .   .   .   .   .   .   .   .   .   .
0102 SITE PREP              : 2EO 1EA>====>   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0103 EXCAVATE FTG/UTILITIES :    .   . 2EO>===>   .   .   .   .   .   .   .   .   .   .   .   .   .
1001 INSLAB ELECTRICAL      :    .   .   .3CE>---->............................>  .   .   .   .   .
0901 UNDERSLAB UTILITIES    :    .   .   .1UT>---------------->................>  .   .   .   .   .
0203 SET FORMS FTG/SLAB     :    .   .   . 4BU>============>  .   .   .   .   .   .   .   .   .   .
0302 PLACE CONCRETE LINTELS :    .   .   .2BU>---->.................................>  .   .   .   .
0204 SET RST FTG/SLAB       :    .   .   .   .   .   .2SW>================>  .   .   .   .   .   .
0205 PLACE CONCRETE FTG/SLAB:    .   .   .   .   .   .   .   .   .   .6BU>====>   .   .   .   .   .
0206 STRIP FORMS FTG/SLAB   :    .   .   .   .   .   .   .   .   .   .   .2BU>---->.................
0303 ERECT EXT CMU WALLS    :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
1002 ROUGH ELECTRICAL       :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0902 ROUGH PLUMBING         :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0403 INST RST BEAM/CANOPY   :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0404 ERECT FORMS BEAM/CAN   :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0405 PLACE CONCRET BEAM/CA  :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0406 STRIP INSIDE BEAM FORM :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0501 SET BAR JOISTS         :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0502 SET  ROOF PLANKS       :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0503 INSTALL BUILT UP ROOF  :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0701 INTERIOR FRAMING       :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0407 STRIP EXT BEAM FORM    :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0601 HANG EXT DOORS/WIND    :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
1101 CLEAN SEAL PAINT EXT   :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0702 INSTALL/FINISH DRYWAL  :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0801 PLASTER SCRATCH COAT   :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
1102 LANDSCAPE              :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0602 INSTALL INTERIOR DOORS :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0806 INSTALL SUSP CEILING   :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0803 FINISH COAT PLASTER    :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0804 CERAMIC TILE WAINSCOA  :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0802 INSTALL STRUC FACE TILE:    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0805 PREP PRIME PAINT INTERI:    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0808 ASPHALT FLOOT TILE     :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
1003 FINISH ELECTRICAL      :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0903 FINISH PLUMBING        :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0807 CERAMIC FLOOR TILE     :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0809 INSTALL TOILET PARTITIO:    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
1103 MOVE OUT               :    .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
```

MAR	01	02	03	06	07	08	09	10	13	14	15	16	17	20	21	22	23	24
AVERAGE DAILY RESOURCE																		
BUILDER	6	6	~~12~~ 6	~~12~~ 6	~~12~~ 6	~~10~~ 4	~~10~~ 4	~~8~~ 0	0	0	0	6	2	~~0~~ 6	~~0~~ 6	~~0~~ 6	~~8~~ 6	~~8~~ 6
CONSTRUCTION ELECTRICI	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
ENGINEERING AID	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EQUIPMENT OPERATOR	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
STEELWORKER	0	0	6	6	3	3	0	2	2	2	2	0	0	0	0	0	0	0
UTILITIESMAN	0	0	0	0	~~4~~ 2	~~4~~ 2	~~0~~ 2	~~0~~ 2	0	0	0	0	0	0	0	0	0	0
TOTAL RESOURCE	7	7	21	20	22	17	10	8	2	2	2	6	2	0	0	0	0	0

CONSTRUCTION ACTIVITY SUMMARY SHEET

PROJECT TITLE: _____

B.M. CODE: _____ **PREPARED BY:** _____ **CHECKED BY:** _____

START SCHEDULED: _____ FINISH SCHEDULE: _____

ACTUAL: _____ ACTUAL: _____

ACT. NO. _____ GROUP CODE _____

ACT. TITLE: _____

DESCRIPTION OF WORK METHOD: _____

DURATION: ESTIMATED _____ MANDAYS: ESTIMATED _____

ACTUAL _____ ACTUAL _____

Production Efficiency Factor: _____ RESULTING DELAY FACTOR: _____

LABOR RESOURCES:

NO.	DESCRIPTION	QTY.	NO.	DESCRIPTION	QTY.

EQUIPMENT RESOURCES:

NO.	DESCRIPTION	QTY.	NO.	DESCRIPTION	QTY.

MATERIAL RESOURCES:

NO.	DESCRIPTION	QTY.	NO.	DESCRIPTION	QTY.

ASSUMPTIONS: _____

ACTIVITY NUMBER: _____ ACTIVITY DESCRIPTION: _____

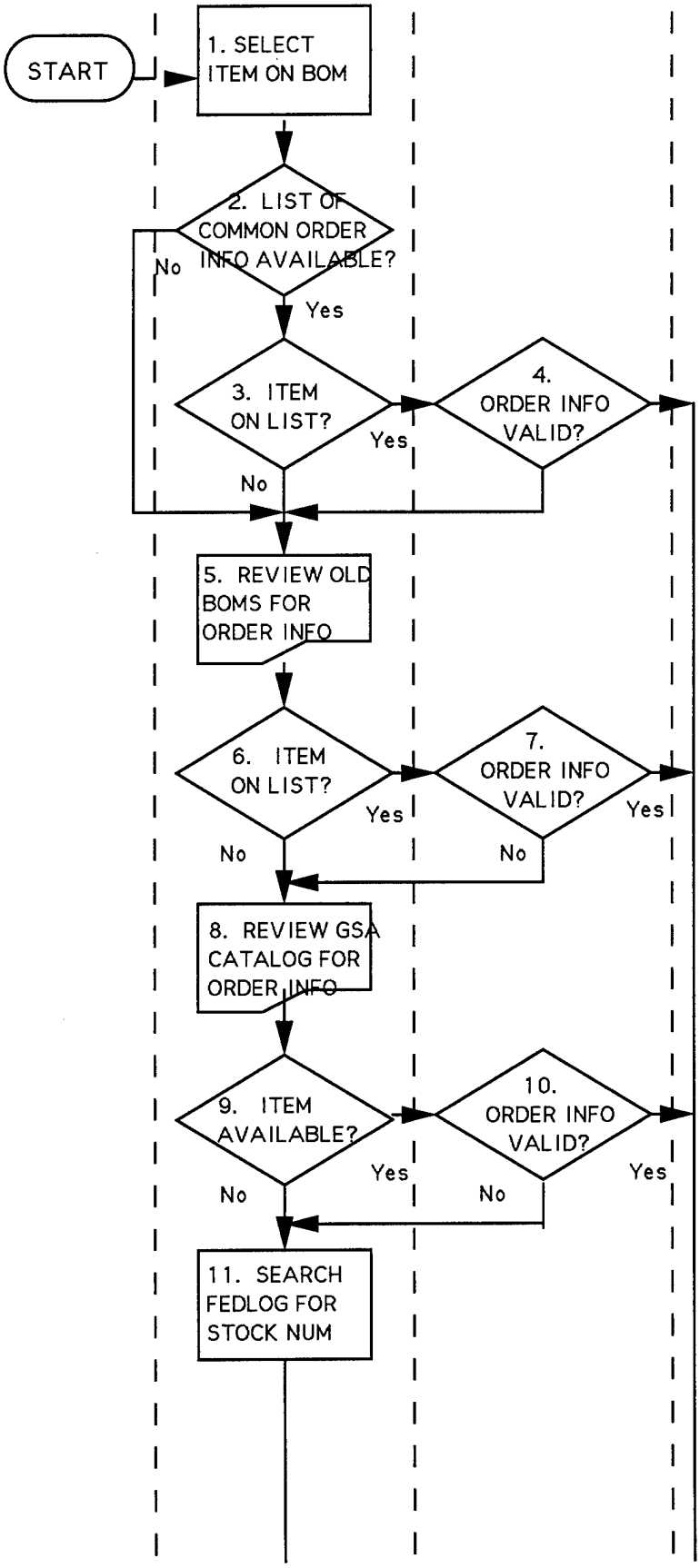
SAFETY HAZARD	SPEC. REF.	REQUIRED ACTION

QUALITY CONTROL REQUIREMENT	SPEC. REF.	REMARKS/RESULTS

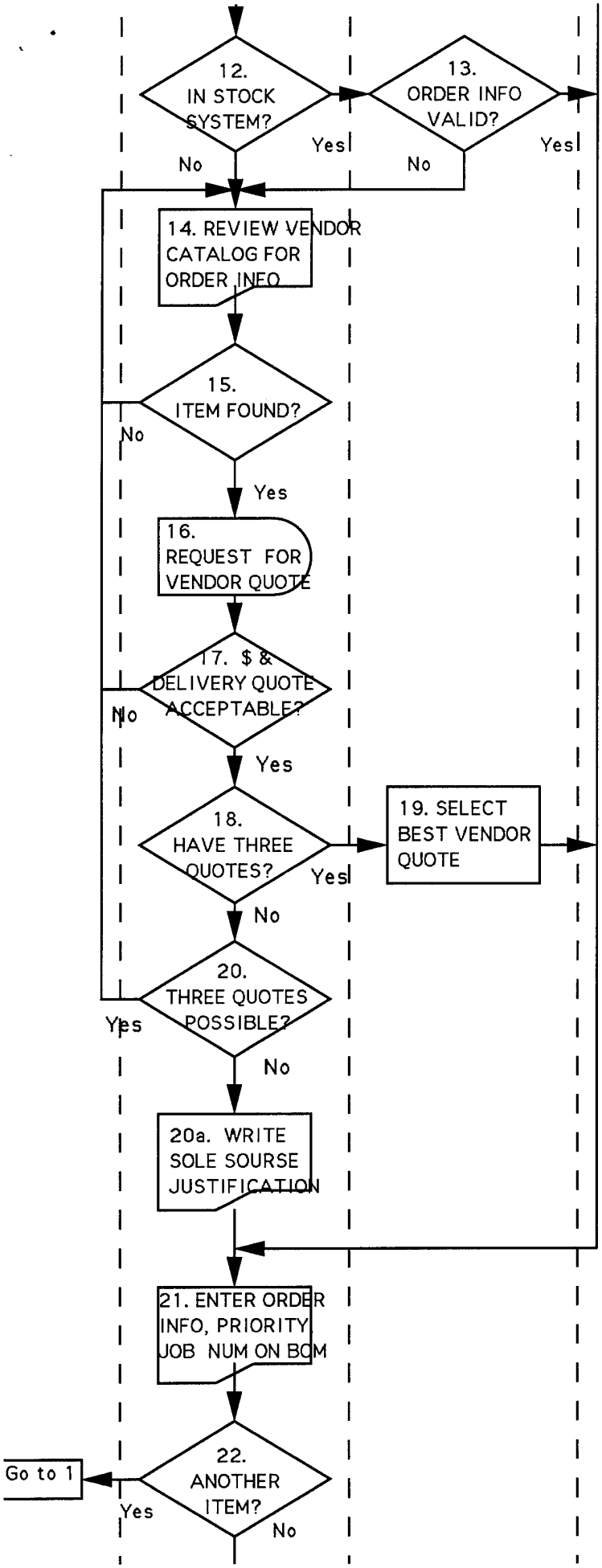
ENVIRONMENTAL HAZARDS	SPEC. REF.	ACTION REQUIRED

CONSTRUCTION COMMENTS:

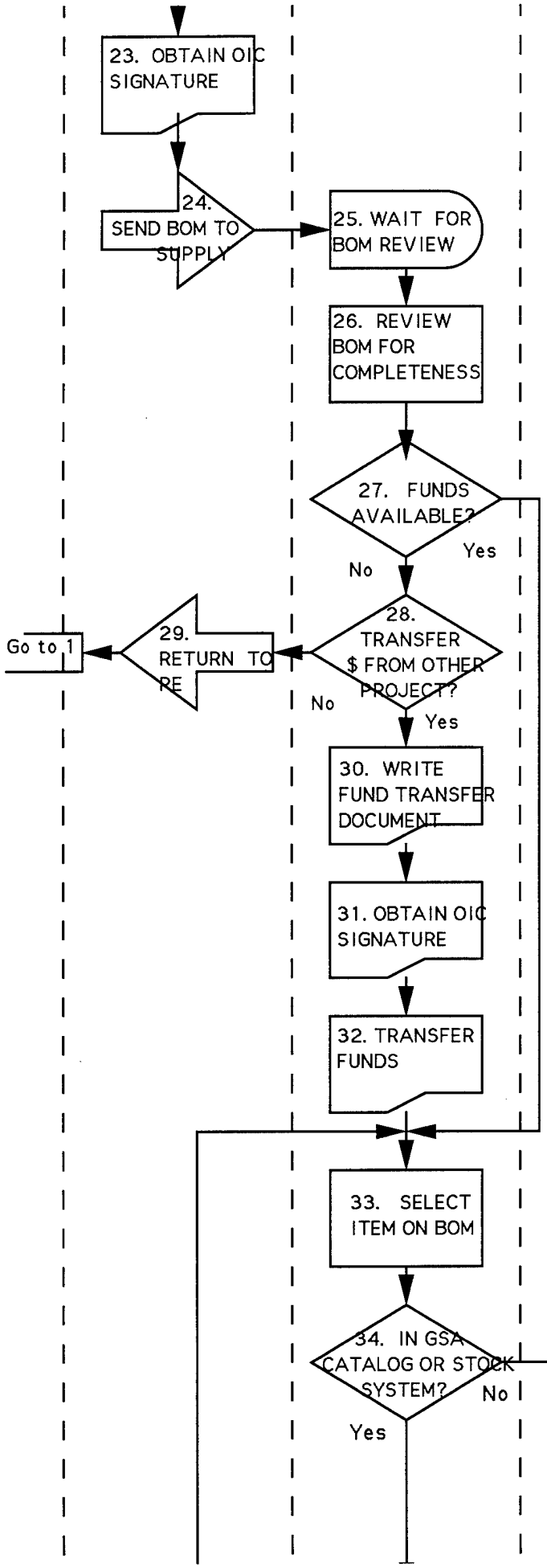
ORDERING PROJECT MATERIAL



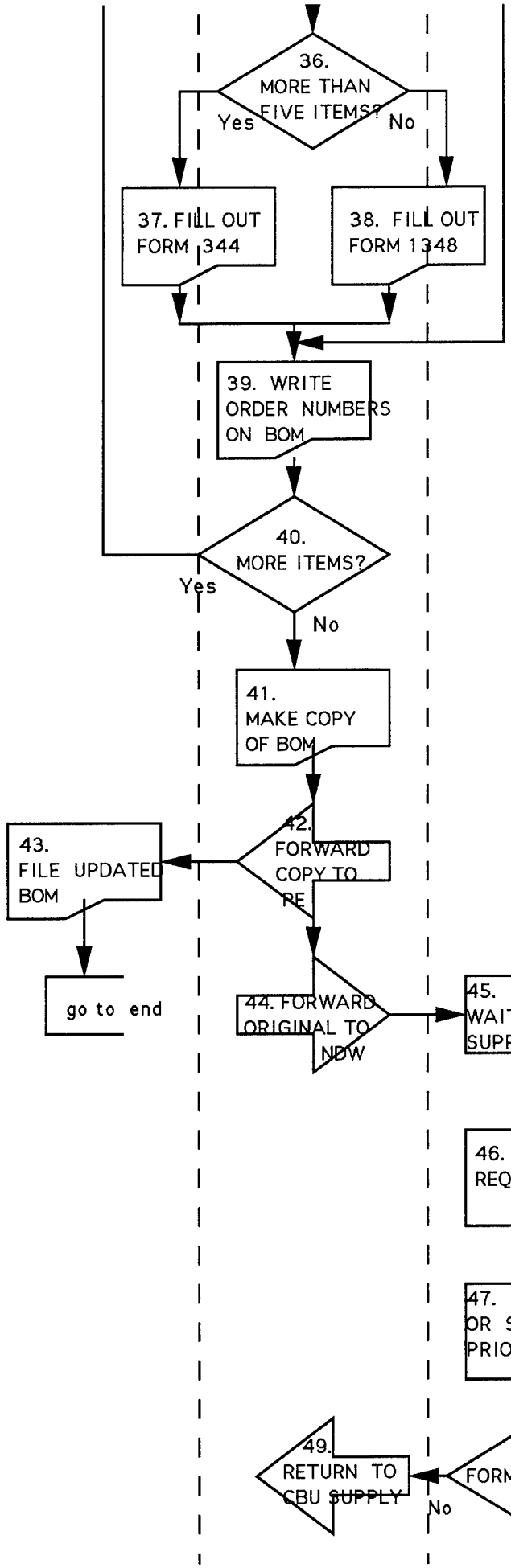
ACTIVITY NUMBER	PROCESS TIME	CYCLE TIME
1	.01	.01
2	.01	.01
3	.25	1.0
4	.25	1.0
5	.5	2.0
6	.25	1.0
7	.25	1.0
8	.25	1.0
9	.25	1.0
10	.25	1.0
11	.25	1.0



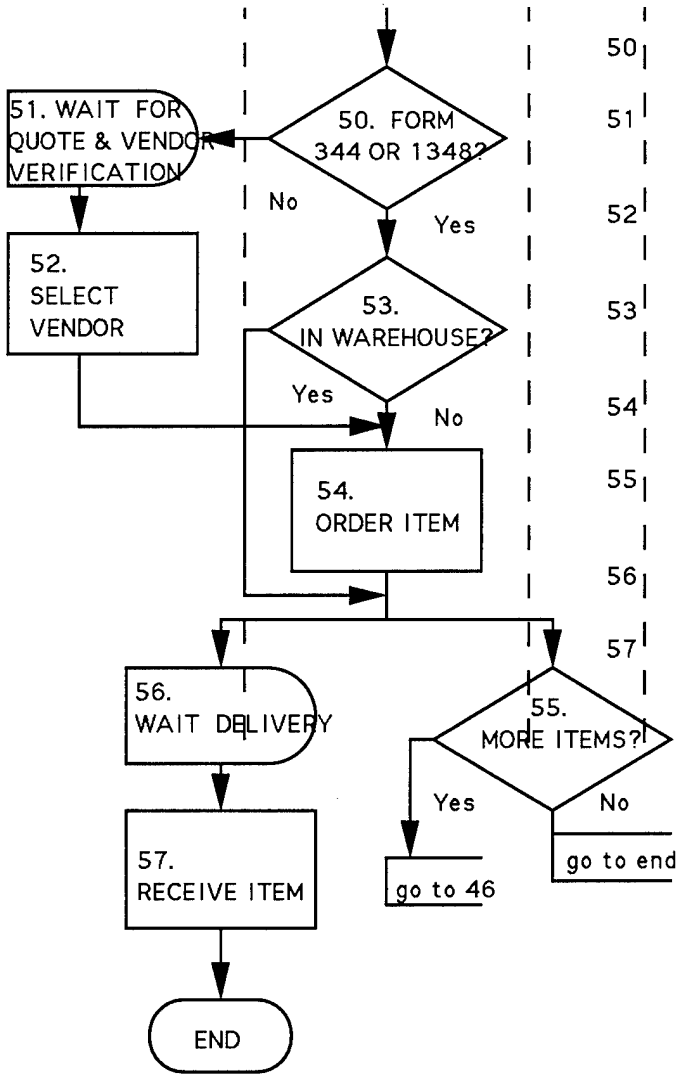
12	.25	1.0
13	.25	1.0
14	.5	1.0
15	.01	.01
16	.25	24.0
17	.05	4.0
18	.05	.05
19	.25	1.0
20	.05	.05
20a	1.0	24.0
21	.1	1.0
22	.01	.01



23	.25	24.0
24	.1	24.0
25		72.0
26	.1	4.0
27	.1	4.0
28	.25	4.0
29	.1	24.0
30	.5	12.0
31	.25	24.0
32	.25	24.0
33	.01	.01
34	.01	.01
35	.25	1.0

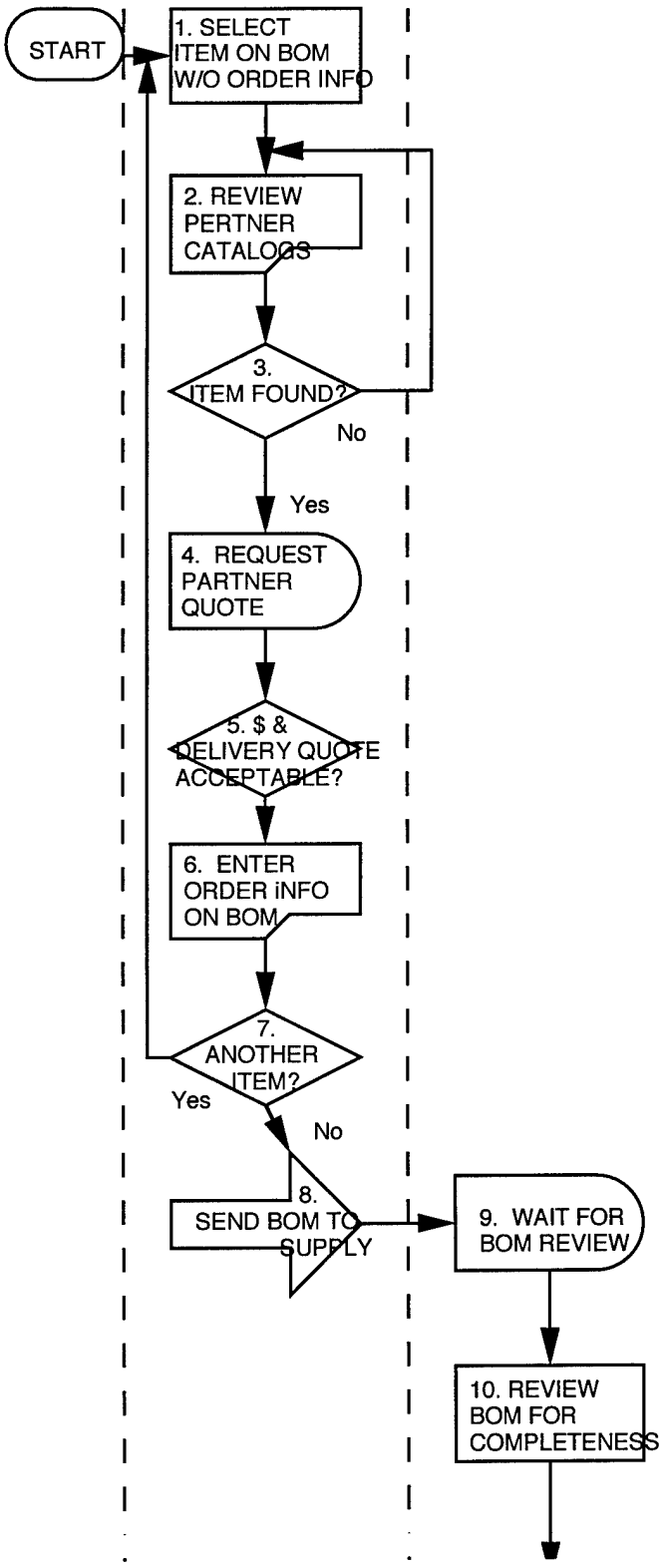


36	.01	.01
37	.25	1.0
38	.25	1.0
39	.1	1.0
40	.01	.01
41	.1	2.0
42	.1	24.0
43	.1	24.0
44	.5	48.0
45		120.0
46	.05	.05
47	1.0	4.0
48	.01	.01
49	.5	48.0

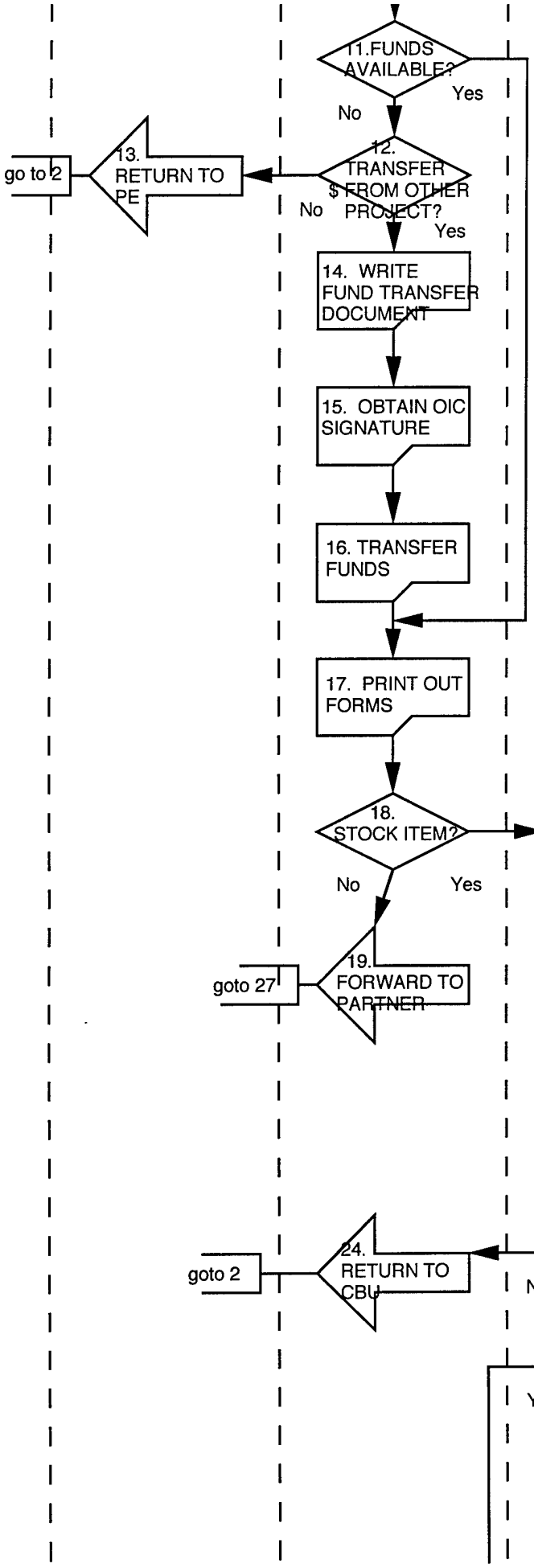


50	.01	.01
51	1.0	24.0
52	.25	1.0
53	.25	4.0
54	1.0	48.0
55	.01	.01
56		120.0
57	.5	24.0

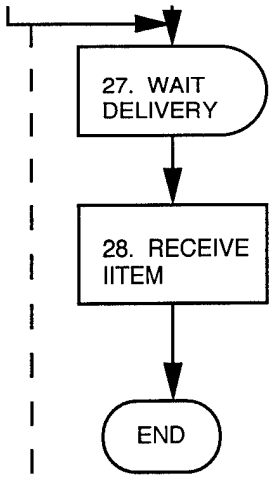
ORDERING PROJECT MATERIAL STREAMLINED



ACTIVITY NUMBER	PROCESS TIME	CYCLE TIME
1	.01	.01
2	.5	1.0
3	.01	.01
4	.25	24.0
5.	.05	.05
6	.1	.1
7	.01	.01
8	.1	24.0
9		72.0
10	.1	4.0



11	.1	4.0
12	.25	4.0
13	.1	24.0
14	.5	12.0
15	.25	24.0
16	.25	24.0
17	1.0	1.0
18	.01	.01
19	.5	48.0
20	.5	48.0
21	.01	.01
22	1.0	4.0
23	.01	.01
24	.5	48.0
25	.25	4.0
26	1.0	48.0



27		120.0
28	.5	24.0